Enclosure (1) to LMSC/D243428
10 September 1971

EIGHTH QUARTERLY PROGRESS REPORT
FOR
LOCKHEED EXPERIMENT ON ATS-5
(1 June through 31 August 1971)

Contract No. NAS 5-10392

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For:

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ABSTRACT

Results of the coordinated observations of the magnetospheric substorm occurring at 05:30 on 13 February 1970 are presented. Progress in several other areas of analysis of the data from the Lockheed experiment on ATS-5 is outlined.

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INTRODUCTION

During this reporting period, an invited paper on the ATS-5 results was presented at the XV General Assembly of the IUGG in Moscow, USSR, by Drs. R. D. Sharp and R. G. Johnson, and a paper entitled "Coordinated Auroral Electron Observations from a Synchronous and a Polar Satellite, by R. D. Sharp, D. L. Carr, R. G. Johnson, and E. G. Shelley, was accepted for publication by the Journal of Geophysical Research. Substantial progress in the analysis of the data has been achieved in several other areas as described below.

DISCUSSION

The detailed analysis of the substorm at 0530 on Day 44, 1970 has been largely completed and a paper is in the course of preparation (see Seventh Quarterly Progress Report). Besides members of our group, co-authors on the paper will include: Dr. Steven Mende, Lockheed Palo Alto Research Laboratory, who provided the all-sky camera data; Dr. Gerhard Haerendel of the Max-Planck-Institute of Extraterrestrische Physik in Munich, who analyzed the current systems; and Dr. Edward Hones of Los Alamos Scientific Laboratory, who provided the VELA data in the magnetotail. Some of the data from this substorm event are shown in Figures 1 through 10.

Work is currently in progress in four other major areas.

1) Dr. Shelley is continuing his studies of the average properties of the energetic plasma at synchronous altitude. A previous analysis of a limited body of data from an engineering standpoint was presented by

E. G. Shelley and S. K. Lew at the National Symposium on Natural and Man-Made Radiation in Space, 2-5 March 1971 at Las Vegas, Nevada. The present effort, in addition to increasing the quantity of data in the study, will emphasize the physical significance of the various systematics and regularities that have been discovered.

2) Dr. Sharp is making a study of the temporal variations of the plasma properties during three contrasting periods of magnetic activity, each of about five days duration. They include one quiet period, the magnetic storm period of 29 September-2 October 1969, and one non-storm period of substantial activity. The ATS-5 in-situ measurements of the ring current are compared with variations in the D_{st} index; and substorm variations in the electron and proton fluxes are compared to auroral zone magnetometer data from stations near the foot of the ATS-5 field line.

3) A statistical study of the plasma variations during a number of substorms has been initiated by Mr. D. L. Carr. He is using as a fiducial mark the characteristic signature in the energetic ($E > 38$ keV) protons which has been found to be indicative of both the time and the place of the initiation of the magnetospheric collapse (see Third Quarterly Progress Report, Page 12). This study will investigate whether there are a critical set of plasma conditions which are necessary to initiate this substorm instability.

4) A follow-on to the coordinated ATS-5/OV1-18 study of simultaneous electron measurements (J. Geophys. Res., in press, see Sixth Quarterly Progress Report) is being undertaken by Mr. L. F. Smith. This will be a similar comparison of the simultaneous auroral proton measurements from the two satellites.

RECOMMENDATIONS

The above-described projects are representative of a large number of investigations of the data from the Lockheed experiment which could profitably be performed. Each of them could substantially further out knowledge of the physics of the magnetosphere. We urge that data analysis funding not be terminated at this point. The large investment made in acquiring

the data and developing the computer programs necessary to process it is just at the point of substantial payoff and it would be extremely unfortunate to stop work now.

R. D. Sharp

R. D. Sharp
Project Manager

FIGURE CAPTIONS

FIGURE 1 Map of Canada showing stations from which data is available and the conjugate point to the ATS-5 satellite.

FIGURE 2 Fort Churchill magnetogram and K_p values showing isolated nature of the event.

FIGURE 3 Flux changes observed at breakup compared to Thompson magnetograms.

FIGURE 4 Plasma properties for the day of the event (Day 44) and the quiet day previous.

FIGURE 5 The diamagnetic pressure of the particle fluxes (top curve), the total magnetic field at ATS-5 (center curve), and the ratio of perpendicular particle pressure to magnetic field pressure (lower curve).

FIGURE 6 Expanded scale showing electron plasma properties during the growth phase of the substorm.

FIGURE 7 Expanded scale showing additional plasma properties and magnetic field variations during the growth phase.

FIGURE 8 VELA-5B proton data compared to ATS-5 proton data during the substorm.

FIGURE 9 Expansion of faw detector outputs (counts/second) near the time of the auroral breakup.

FIGURE 10 A comparison of the magnetic field variations (inverted scale) and the diamagnetic effect of the particles in gammas.

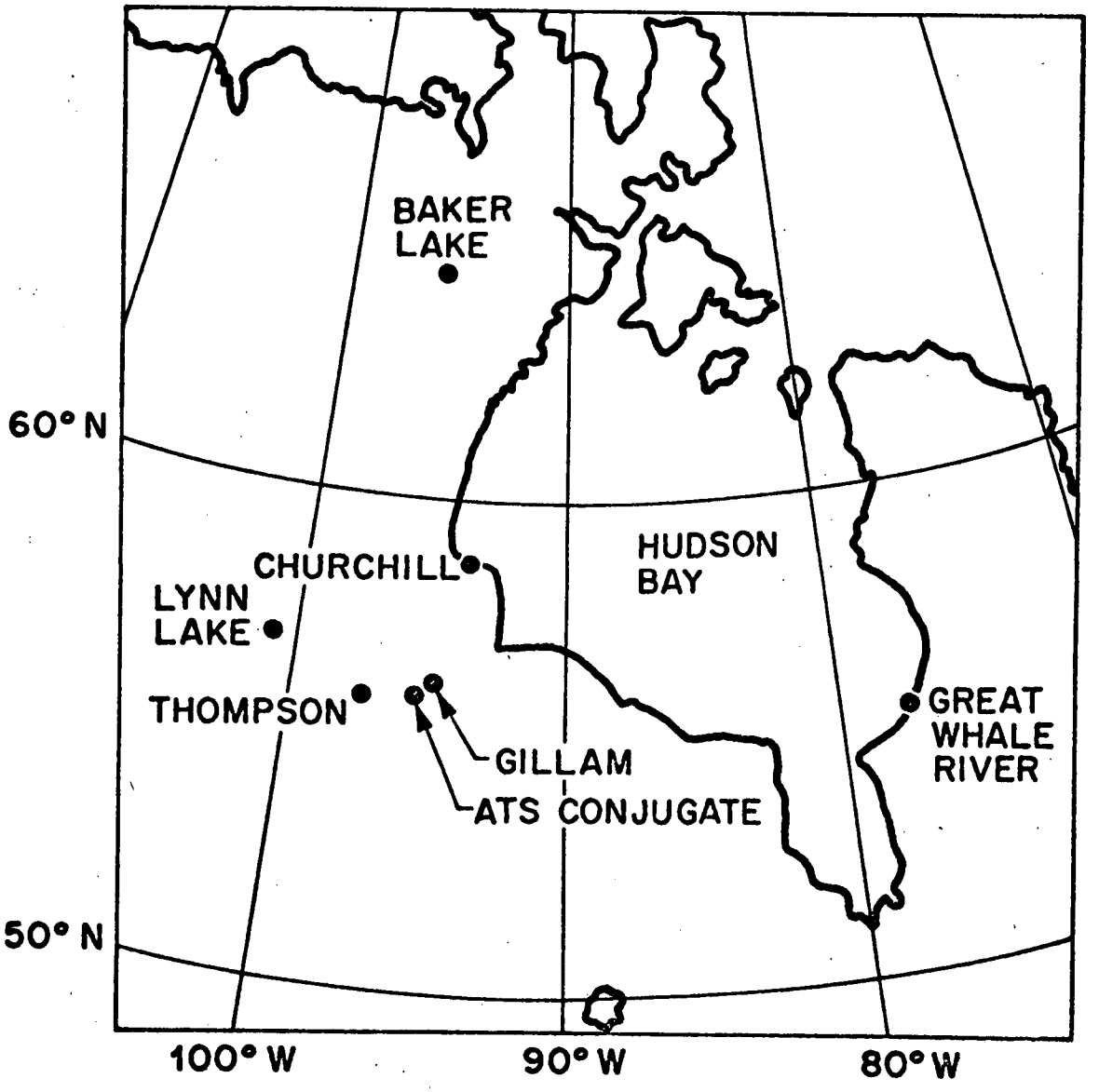
BAKER
LAKE
60° N
CHURCHILL
HUDSON
BAY
LYNN
LAKE
THOMPSON
GILLAM
ATS CONJUGATE
GREAT
WHALE
RIVER
50° N
100° W
90° W
80° W

FIGURE 1

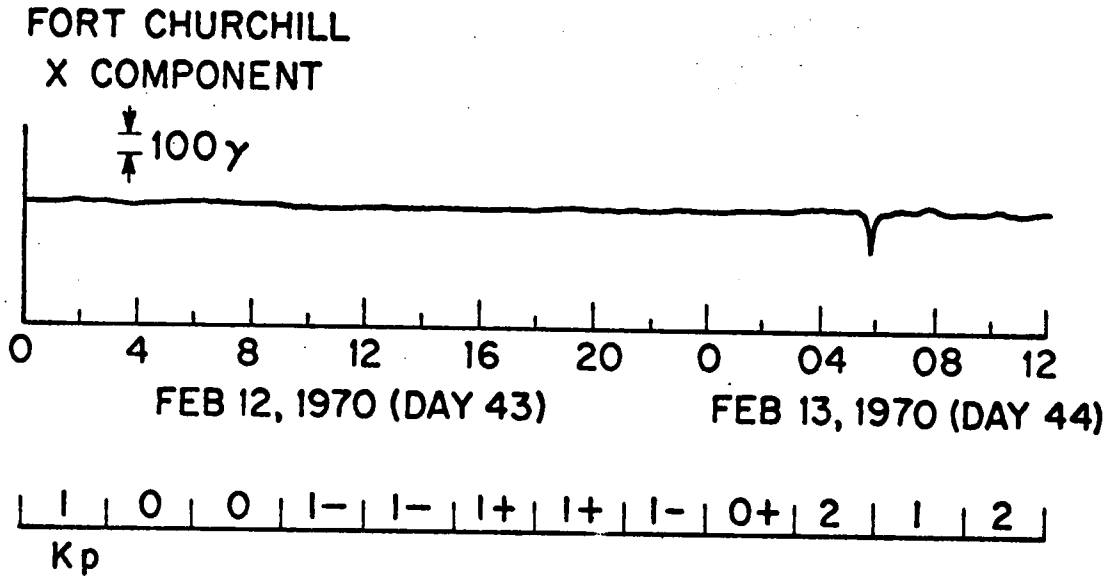
FORT CHURCHILL
X COMPONENT
100γ
0 4 8 12 16 20 0 04 08 12
FEB 12, 1970 (DAY 43)
FEB 13, 1970 (DAY 44)
1 0 0 1− 1− 1+ 1+ 1− 0+ 2 1 2
Kp

FIGURE 2

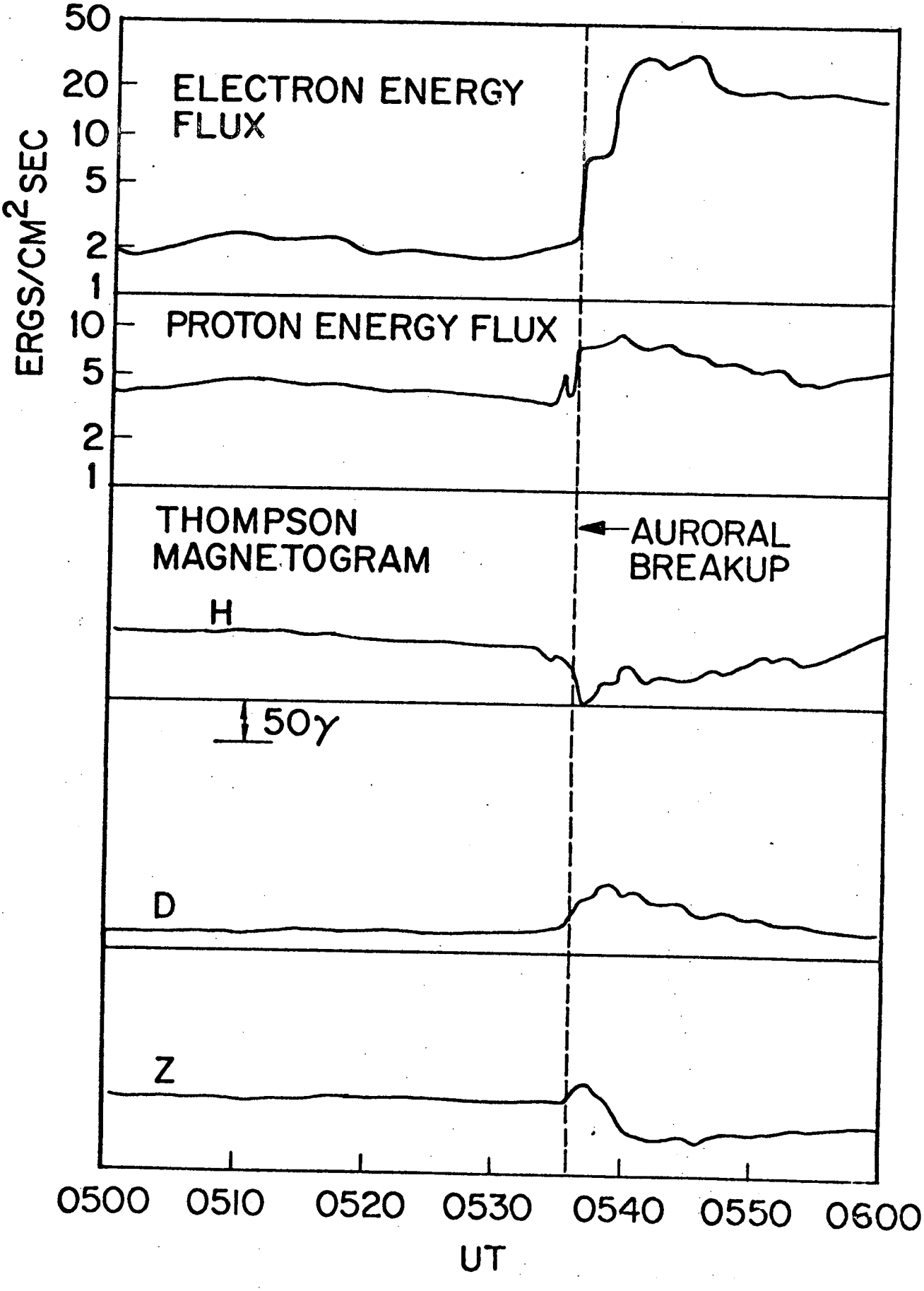
ELECTRON ENERGY FLUX
PROTON ENERGY FLUX
ERGS/CM² SEC
50
20
10
5
2
1
10
5
2
1
THOMPSON MAGNETOGRAM
AURORAL BREAKUP
H
50γ
D
Z
0500
0510
0520
0530
0540
0550
0600
UT

FIGURE 3

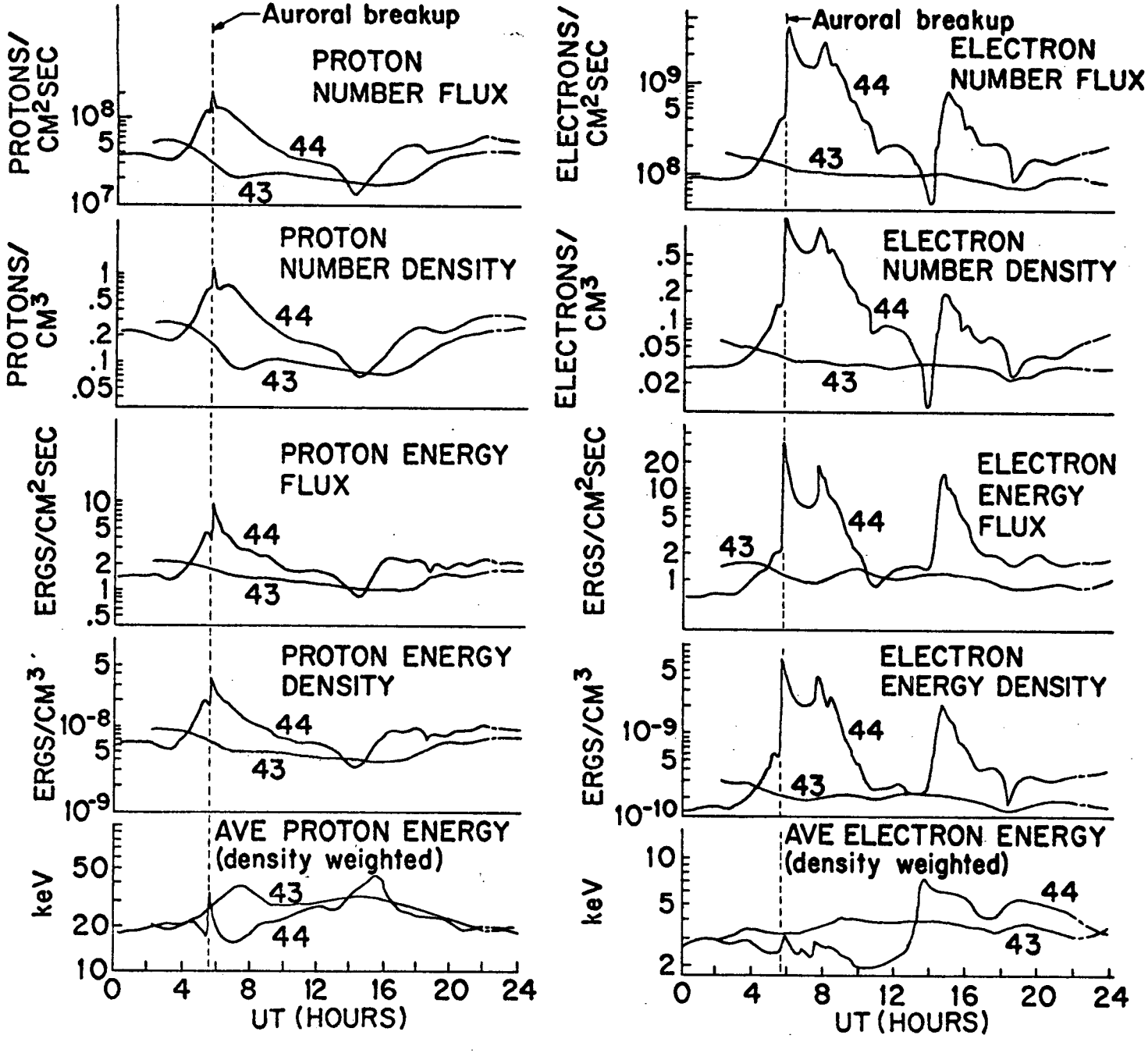
Auroral breakup
PROTONS/ CM²SEC
PROTON NUMBER FLUX
PROTONS/ CM³
PROTON NUMBER DENSITY
ERGS/CM²SEC
PROTON ENERGY FLUX
ERGS/CM³
PROTON ENERGY DENSITY
keV
AVE PROTON ENERGY (density weighted)
ELECTRONS/ CM²SEC
ELECTRON NUMBER FLUX
ELECTRONS/ CM³
ELECTRON NUMBER DENSITY
ELECTRON ENERGY FLUX
ELECTRON ENERGY DENSITY
AVE ELECTRON ENERGY (density weighted)
44
43
UT (HOURS)

FIGURE 4

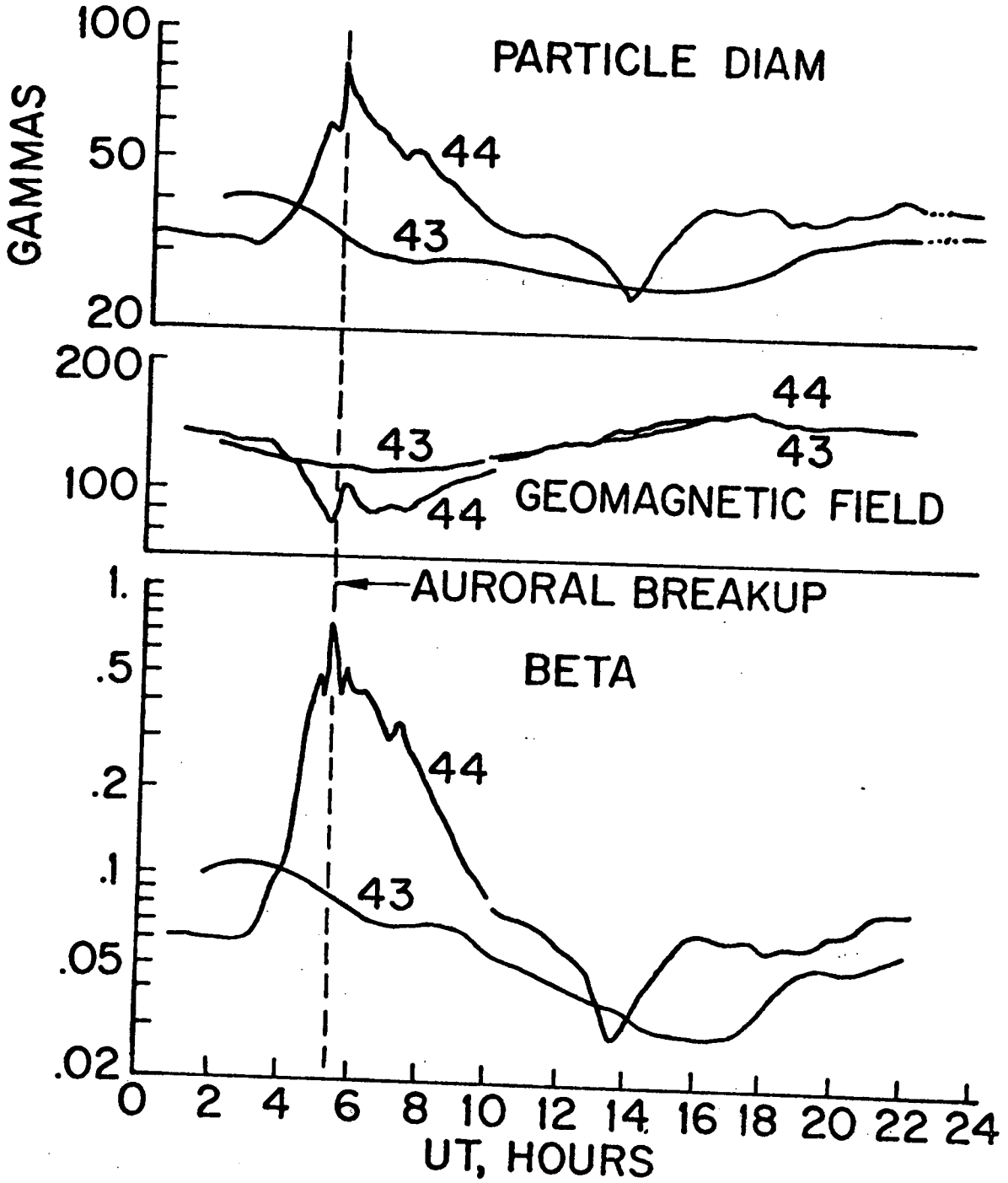
GAMMAS
100
50
20
PARTICLE DIAM
44
43
200
100
44
43
43
44
GEOMAGNETIC FIELD
AURORAL BREAKUP
1.
.5
.2
.1
.05
.02
BETA
44
43
0 2 4 6 8 10 12 14 16 18 20 22 24
UT, HOURS

FIGURE 5

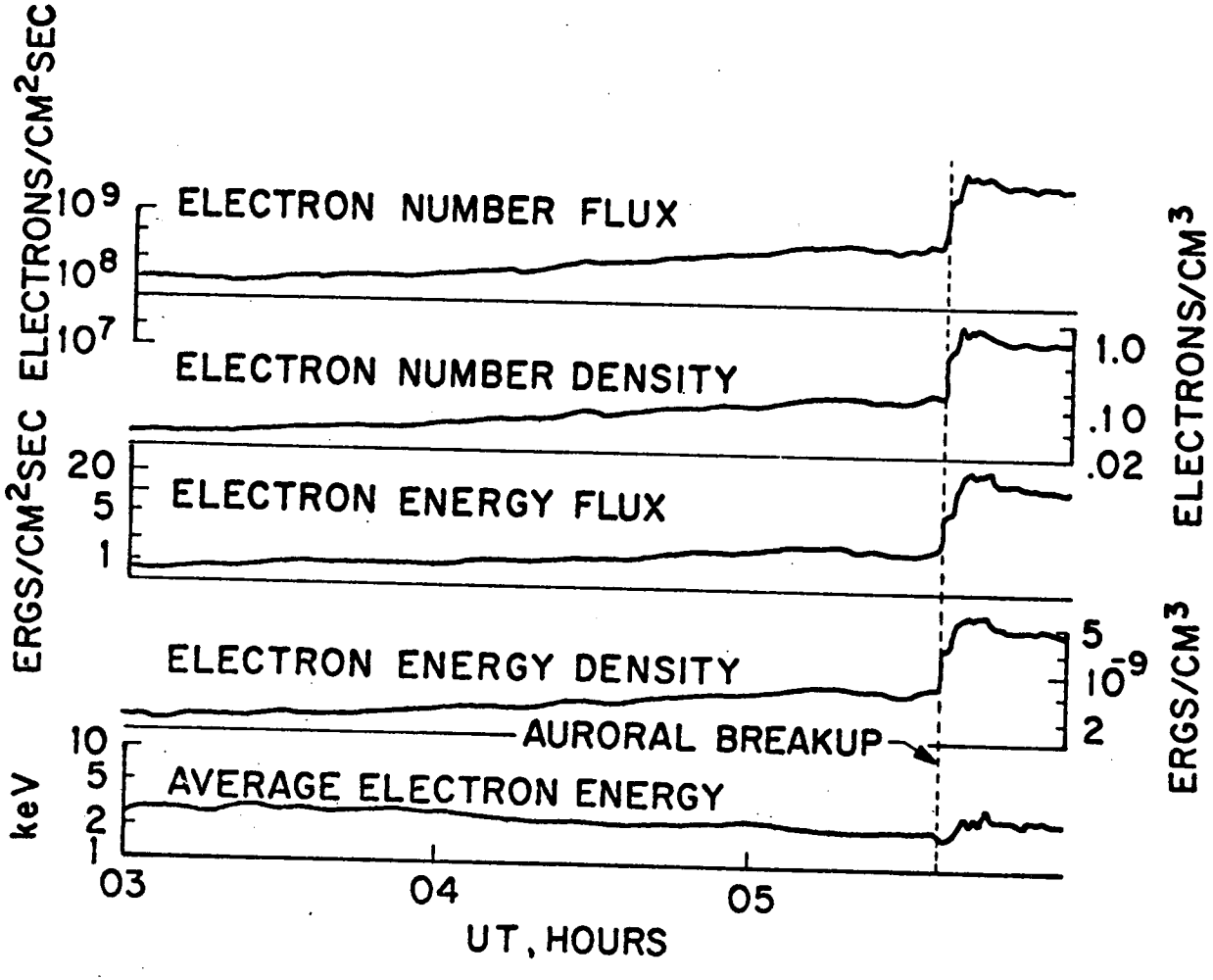
ELECTRONS/CM²SEC
ELECTRON NUMBER FLUX
10⁹
10⁸
10⁷
ELECTRON NUMBER DENSITY
1.0
.10
.02
ELECTRONS/CM³
ERGS/CM²SEC
20
5
1
ELECTRON ENERGY FLUX
ELECTRON ENERGY DENSITY
5
10⁻⁹
2
ERGS/CM³
AURORAL BREAKUP
keV
10
5
2
1
AVERAGE ELECTRON ENERGY
03
04
05
UT, HOURS

FIGURE 6

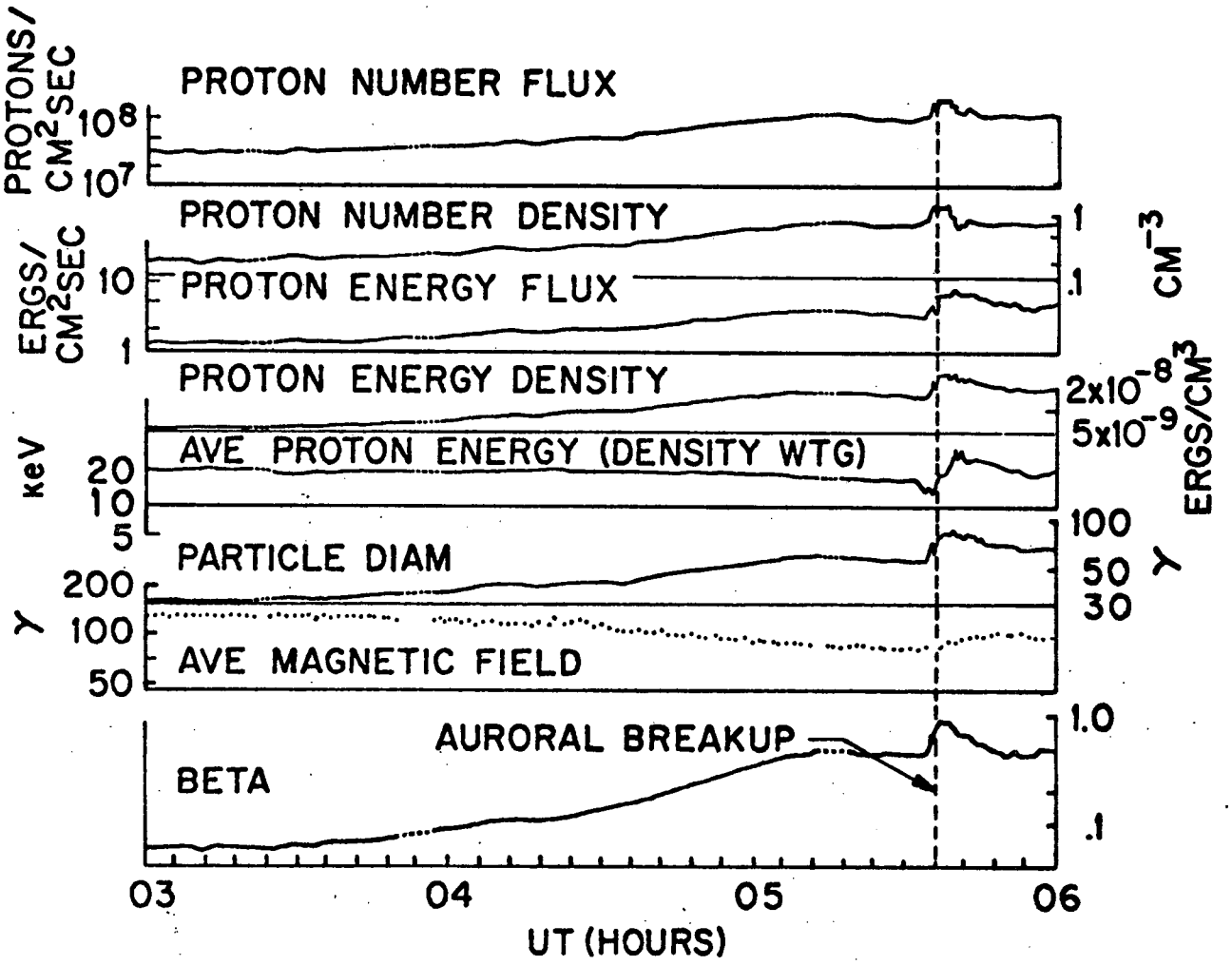
PROTONS/ CM²SEC
PROTON NUMBER FLUX
10⁸
10⁷
PROTON NUMBER DENSITY
1
.1
CM⁻³
ERGS/ CM²SEC
10
1
PROTON ENERGY FLUX
PROTON ENERGY DENSITY
2x10⁻⁸
5x10⁻⁹
ERGS/CM³
keV
20
10
5
AVE PROTON ENERGY (DENSITY WTG)
100
50
30
γ
PARTICLE DIAM
200
100
50
γ
AVE MAGNETIC FIELD
AURORAL BREAKUP
1.0
.1
BETA
03
04
05
06
UT (HOURS)

FIGURE 7

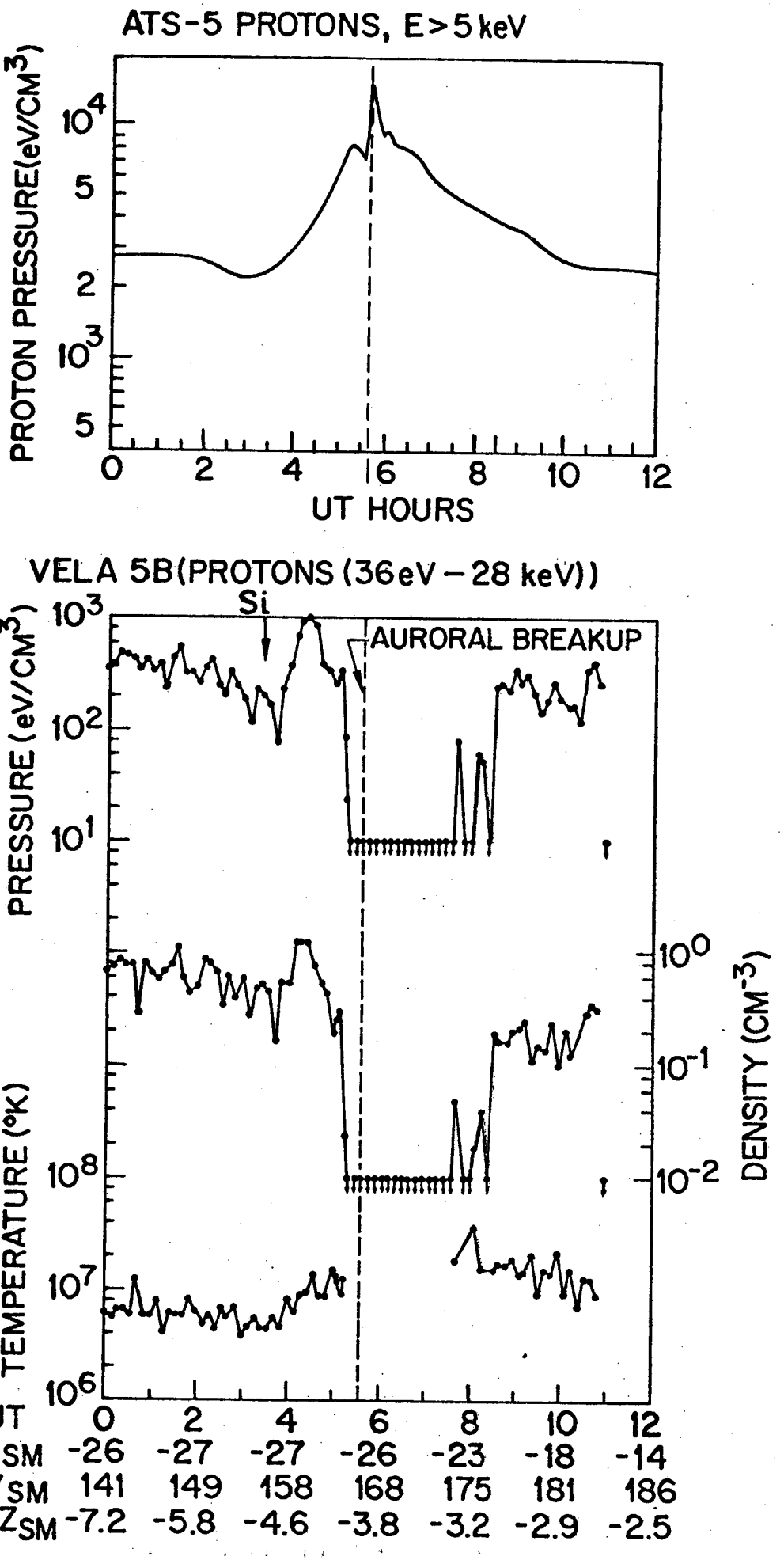
ATS-5 PROTONS, E>5 keV
PROTON PRESSURE(eV/CM3)
10^4
5
2
10^3
5
0
2
4
6
8
10
12
UT HOURS
VELA 5B(PROTONS (36 eV – 28 keV))
PRESSURE (eV/CM3)
10^3
10^2
10^1
Si
AURORAL BREAKUP
10^0
10^-1
10^-2
DENSITY (CM-3)
TEMPERATURE (°K)
10^8
10^7
10^6
UT 0 2 4 6 8 10 12
λSM -26 -27 -27 -26 -23 -18 -14
ΨSM 141 149 158 168 175 181 186
dZSM -7.2 -5.8 -4.6 -3.8 -3.2 -2.9 -2.5

FIGURE 8

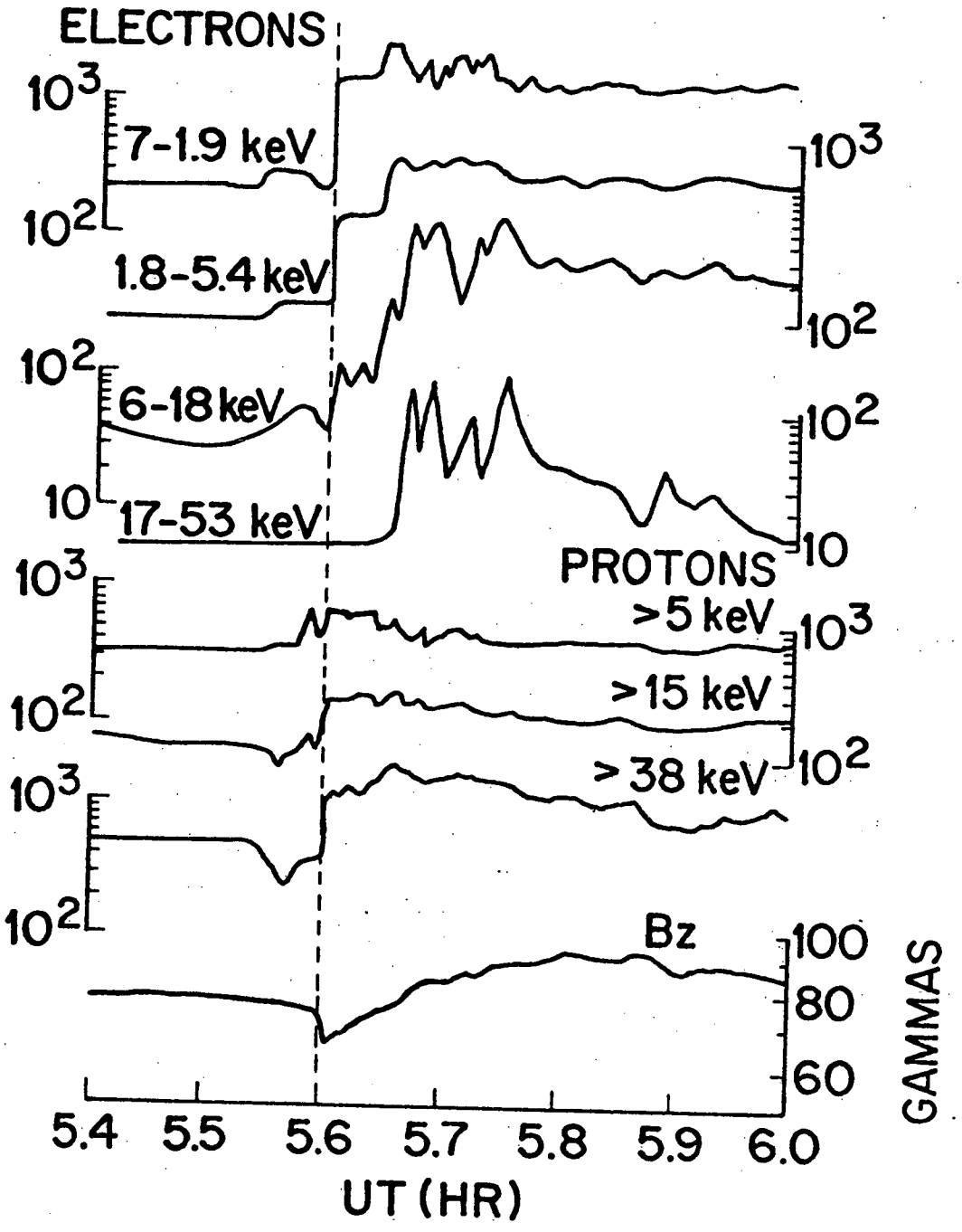
ELECTRONS
10^3
7-1.9 keV
10^2
10^3
1.8-5.4 keV
10^2
10^2
6-18 keV
10
10^2
17-53 keV
10
PROTONS
10^3
>5 keV
10^3
10^2
>15 keV
10^3
>38 keV
10^2
10^3
10^2
Bz
100
80
60
GAMMAS
5.4 5.5 5.6 5.7 5.8 5.9 6.0
UT (HR)

FIGURE 9

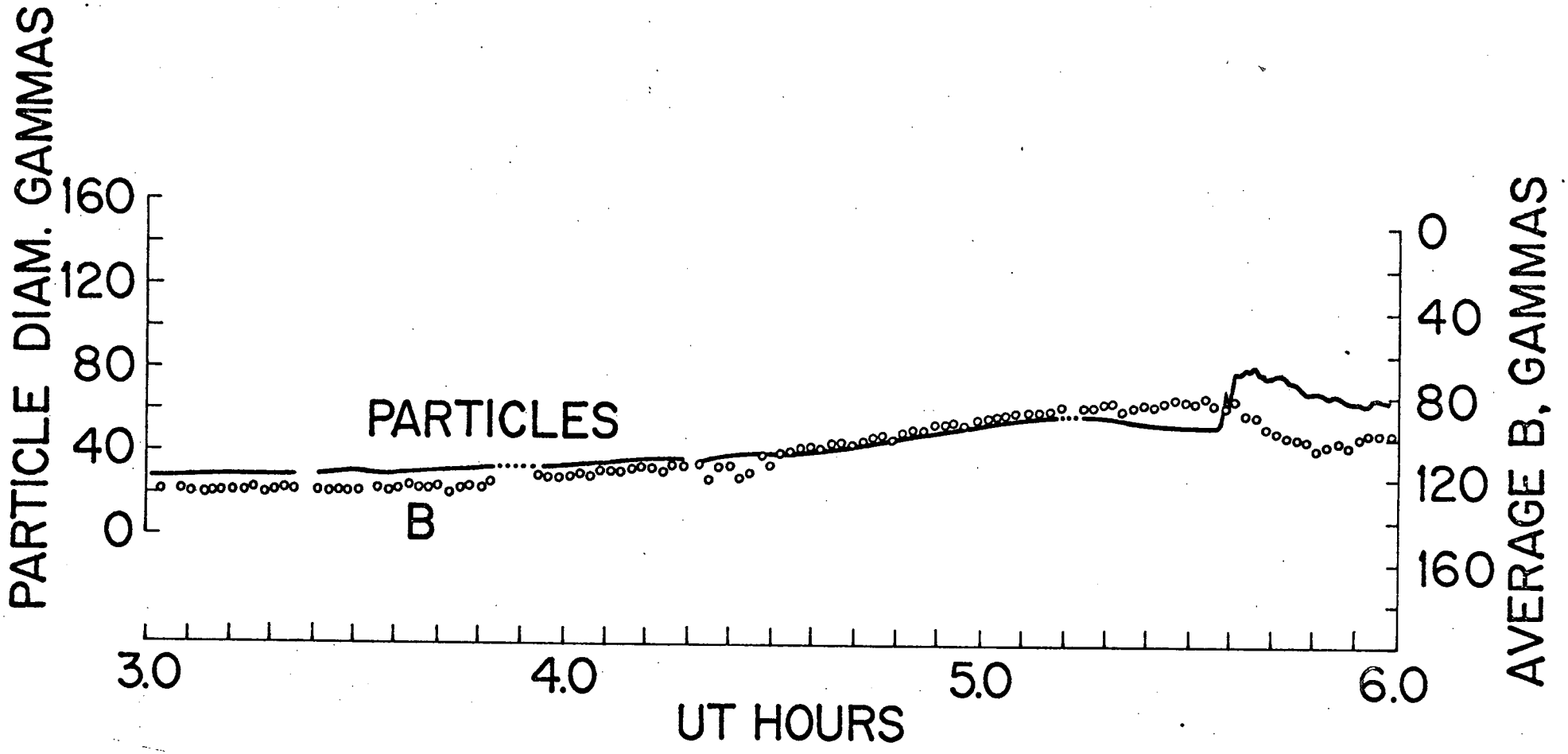
PARTICLE DIAM. GAMMAS
160
120
80
40
0
PARTICLES
B
3.0
4.0
5.0
6.0
UT HOURS
0
40
80
120
160
AVERAGE B, GAMMAS

FIGURE 10